PAPER NO. DL.

A COAL CALORIMETER.

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PRESENTED AT

THE MECHANICAL ENGINEERING SECTION

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OF THE

WORLD'S ENGINEERING CONGRESS, CHICAGO, ILL., U. S. A.

JULY, 1893.

Accepted by the Council of the American Society of Mechanical Engineers, and to form part of Volume XIV. of the *Transactions*.

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No. 12 West 31st Street,
New York City, N. Y., U. S. A.

DL.*

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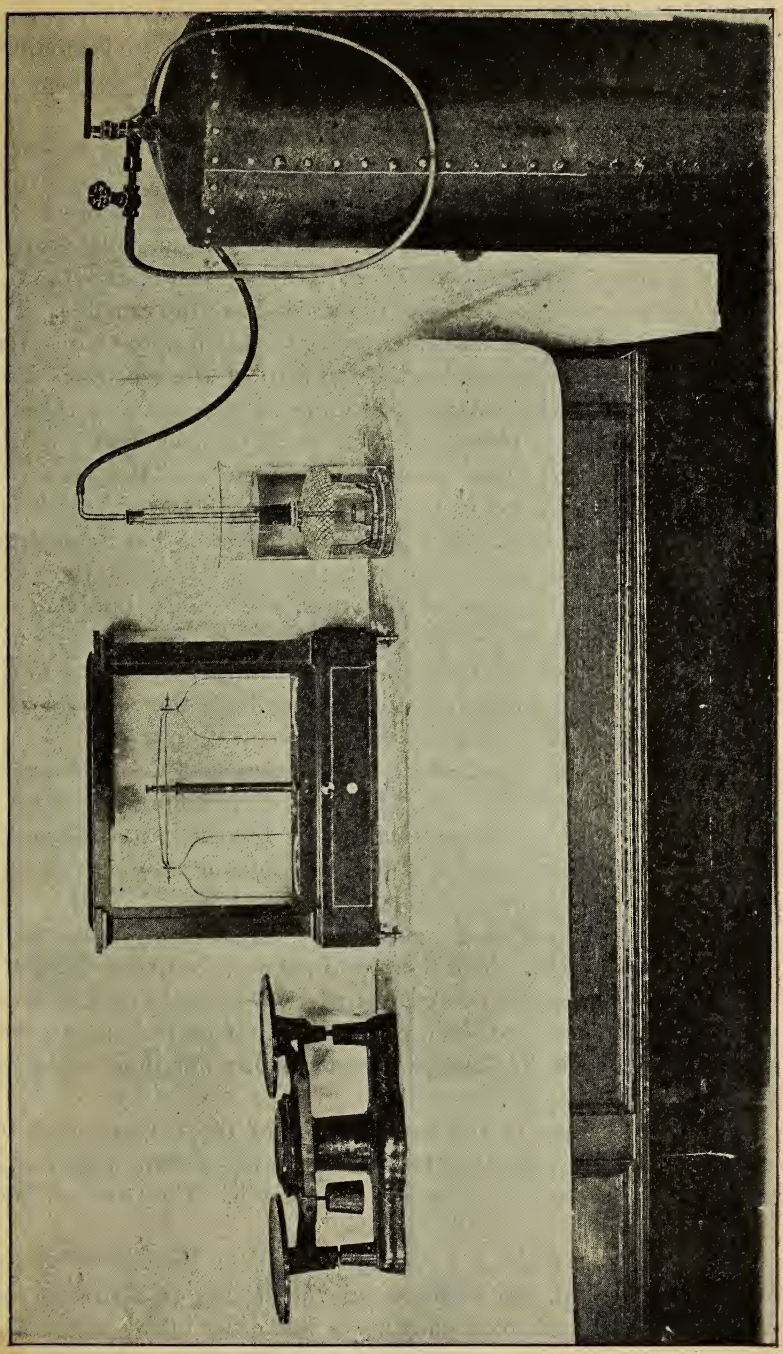
In view of the prominence given to the determination of the quality of coal used on locomotive tests by the employment of some form of oxygen calorimeter, which is given in the report of the Committee on Locomotive Tests presented at this meeting, it seems desirable to record some of the results which have been obtained by the use of one form of the instrument referred to, as designed and operated by the writer.

The instrument has been employed for the past three years, and during that time samples of nearly one hundred different coals have been subjected to the calorimeter test. No definite line of investigation has been undertaken to determine the heat of combustion of selected varieties of coal. The tests have been made on coal which has been used on evaporative trials of boilers which the writer has conducted, and on samples which have been submitted to him from time to time by clients who wished the value of the coal obtained. A large share of the fuels are coals mined in Maryland, Virginia, and Eastern Pennsylvania. Few coals from points in the United States farther west have been tried.

It is proposed here to give a brief description of the apparatus and a tabular summary of the results of a portion of the tests.

The complete apparatus is shown in the accompanying half-tone cut. The calorimeter itself, which lies at the right near the tank, consists of a glass vessel 5 inches in diameter, $9\frac{1}{2}$ inches high, which holds the water of the calorimeter. Submerged in the interior is a bell-shaped glass vessel $2\frac{1}{2}$ inches in diameter, 4 inches high, having a long neck $\frac{3}{4}$ inch in diameter, which is closed at the top with a stopper. The upper end of the neck stands 5 inches above the top of the outside vessel. The glass bell, or "combustion chamber," as it may be termed, rests upon a metal base, to which it is held by means of spring clips, the bottom of the chamber

* Presented at the Chicago meeting (July, 1893) of the American Society of Mechanical Engineers, and forming part of Volume XIV. of the *Transactions*.



being provided with an exterior rib by means of which the clips are made fast. The base is perforated, and at the centre is mounted a short tube, for the reception of a crucible, in which the combustion takes place. The crucible is made of platinum. It is surrounded by a layer of non-conducting material, which is placed between it and the outer metal. A small glass tube is inserted in the stopper at the top of the neck, and this is carried down to the interior of the combustion chamber. It is fitted somewhat loosely, so that a slight pressure will move it up or down, and thereby adjust its lower end to any height desired above the crucible. The tube has a slight lateral movement also, so that it may be directed, at the will of the operator, toward any part of the crucible. This tube is connected with a tank containing oxygen gas, and through it a current of gas is passed, so as to enable the combustion of the coal to be carried on under water. The pressure of the gas drives out the water which would otherwise fill the chamber, and keeps its level below the base. The products of combustion rising from the crucible pass downward through the perforations in the base, escaping around the edge of the base, and finally bubbling up through the water, and emerging at its surface. A wire screen is secured to the neck of the combustion chamber, extending to the sides of the outer vessel, thereby holding back the gas and preventing its immediate escape to the surface of the water.

In making a test, the quantity of water used is 2 kilogrammes or 2,000 grammes, and the quantity of coal 1 gramme. The equivalent calorific value of the material of the instrument is 185 milligrammes. One degree rise of temperature of the water corresponds therefore to a total heat of combustion of 2,185 B. T. U. The number of degrees rise of temperature for ordinary coals varies from $5\frac{1}{2}°$ to $6\frac{1}{2}°$ Fahr. The thermometer used for determining the temperature of the water is graduated to twentieths of a degree; and as the divisions are about one-thirtieth of an inch apart, they may be subdivided by the eye so as to readily obtain a reading to hundredths of a degree.

The scales shown at the extreme left of the cut are used for weighing out the water, and the chemical scales shown in the centre are employed in weighing the coal and the ash. The latter are sensitive to a fraction of a milligramme.

The process of making a test is as follows: Having dried and pulverized the coal, and weighed out the desired quantities of coal and water, the combustion chamber is immersed in the water for a

short time, so as to make the temperature of the whole instrument uniform with that of the water. On its removal, the initial temperature of the water is observed, the top of the chamber lifted, the gas turned on, and the coal quickly lighted, a small paper fuse having previously been inserted in the crucible for this purpose. The top of the combustion chamber is quickly replaced, and the whole returned to its submerged position in the water. The combustion is carefully watched as the process goes on, and the current of oxygen is directed in such a way as to secure the desired rate and conditions for satisfactory combustion. When the coal is entirely consumed, the interior chamber is moved up and down in the water until the temperature of the whole has become uniform, and finally it is withdrawn and the crucible removed. The final temperature of the water is then observed, and the weight of the resulting ash.

The initial temperature of the water is so fixed by suitably mixing warm and cold water that it stands at the same number of degrees below the temperature of the surrounding atmosphere (or approximately the same) as it is raised at the end of the process above the temperature of the air. In this way the effect of radiation from the apparatus is overcome, so that no provision in the matter of insulation is required, and no allowance needs to be made for its effect.

The accompanying table presents a list of sixty-one of the tests which have been made with the instrument. In many cases the name of the mine is given, but in a large number the only information presented regarding the locality from which the coal was obtained is the commercial name by which it is known in the market. In some cases merely the general class of the coal is stated, whether bituminous or anthracite.

RESULTS OF TESTS WITH THE BARRUS COAL CALORIMETER.

Cumberland Coals.

Number for Reference.	Kind of Coal: Mine or Locality.	Percentage of Ash.	Total heat of Combustion.
1		7.6	13,868
2		8.2	14,058
3	George's Creek	6.1	14,217
4	" "	6.6	13,925
5	" "	8.6	12,874
6	" "	6.5	12,921
7	" "	7.	13,360
8	" " (American Co)	5.	13,487
9	" " (Md. Coal Co.)	5.1	13,656
10	" " (G. C. Coal and Iron Co.)	5.7	13,424
11		6.1	13,534
12	George's Creek	5.1	13,745
13		7.5	13,617
14	Eureka	5.1	13,653
15	"	5.4	13,427
16		8.	12,973
17	George's Creek	4.4	13,923

Miscellaneous Bituminous Coals.

18	Pocahontas	6.2	13,608
19	"	4.	14,121
20	"	5.	14,114
21	"	6.5	13,697
22	"	3.2	14,603
23	Clearfield	4.7	13,640
24	"	11.1	12,517
25	New River	0.6	14,273
26	"	1.	14,455
27	"	5.7	13,858
28	"	3.5	13,922
29	"	5.	13,858
30	"	4.1	13,922
31	Welsh (English)	7.7	13,581
32	Lancashire (English)	6.8	12,122
33		8.7	13,402
34		11.	12,983
35	Sonman	6.9	13,326
36	"	8.3	13,267
37	"	7.	13,210
38	Elenora	7.5	12,765
39	"	6.8	12,877
40		7.6	13,016
41		9.1	12,956
42	Eclipse	2.7	14,114
43		5.2	13,474

Number for Reference	Kind of Coal: Mine or Locality.	Percentage of Ash.	Total heat of Combustion.
44	.....	16.5	11,677
45	Elk Garden.....	7.8	13,180
46	Mixture New River and Cumberland.....	6.7	13,361
47	Frontenac (Kansas).....	17.7	10,506
48	Cape Breton (Caledonia)	8.7	12,420
49	Youghiogheny—lump (Acme).....	5.9	12,941
50	" —slack (Pacific).....	10.2	11,664
	ANTHRACITE COALS.		
51	Honey Brook—Chestnut No. 2.....	12.	11,733
52	Cross Creek— " "	10.5	11,521
53	Lackawana—Egg.....	17.5	11.104
54	Broken	9.1	13,189
55	.....	10.6	12,812
56	.....	14.5	11,470
57	.....	11.7	12,146
58	.....	10.9	11,634
59	.....	9.3	12,201
60	.....	15.	11,086
61	.....	13.2	12,412